

“The Oviposition of *Nautilus macromphalus*.” By ARTHUR WILLEY, D.Sc., Balfour Student of the University of Cambridge. Communicated by ALFRED NEWTON, M.A., F.R.S., on behalf of the Managers of the Balfour Fund. Received February 3,—Read February 11, 1897.

*Nautilus macromphalus* is the species of nautilus characteristic of the New Caledonian Archipelago, which comprises the islands of New Caledonia, the Isle of Pines, and the Loyalty Group. I took up my residence on the shores of Sandal Bay, Lifu, in August, 1896. Having collected a number of Nautilus, I placed them in captivity in a large native fish-trap, specially fitted up, fed them twice or three times a week with fish, land-crabs, *Palinurus*, and *Scyllarus*, and on December 5, 1896, commenced to obtain the fertilised ova.

It is not necessary at present to describe the details of manipulation, and I therefore proceed at once to give a brief account of the more obvious features of the eggs as illustrated by the accompanying figures. The eggs are laid singly and at night, in concealed situations, and are firmly attached by a sponge-like reticulate area of attachment placed towards their hinder inflated extremity, usually on one face of the egg-case, but sometimes quite posteriorly, to a suitable surface. I supplied the latter to the Nautilus by fixing pieces of old sacking to the walls of the fish-basket, leaving loose, overhanging folds, beneath which the eggs could be well concealed. The fibres of the sacking were deftly employed by the Nautilus in cementing their eggs.

The ovum is enclosed within a double casing, an inner closed capsule, and an outer capsule more or less freely open in front. The material of which the capsules consist is of a bright milk-white colour, and of firm cartilaginous consistency. The capsules do not collapse, but retain their shape when allowed to dry.

For convenience of description, the exposed surface of the egg may be spoken of as the dorsal or upper side, while the attached side may be referred to as the lower or ventral side. The outer capsule is separate from the inner capsule below and for about two-thirds of the upper side, but is fused with it in the postero-dorsal region. Where the two capsules are fused together the covering of the ovum is much thickened.

The egg with outer covering complete is of remarkably large size, attaining a length of 45 mm., everything included, with a width of 16 mm., and a maximum height of 16.25 mm. The length and the width are fairly constant in normally shaped eggs, but the height varies somewhat, some eggs being a good deal flatter than others.

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In fig. 1 an egg is represented as seen in its usual natural attached position. The depressed or "anterior" end of the egg is, as a rule, directed vertically upwards. The outer capsule is continued in front into two thin, translucent, terminal processes. For nearly half the length of the egg on the upper side the two halves of the outer capsule are separated by a narrow slit from one another and join together behind the centre of the egg. The dorsal ridge or suture of the inner capsule can be seen through this slit in the outer capsule. On the lower side of the egg the two halves of the outer capsule are continuous across the middle line throughout the length of the egg, except at the extreme anterior end.

The surface of the egg in the posterior inflated region is smooth, with a few slight folds like the folds of drapery, giving it a graceful

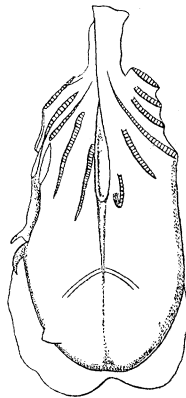


FIG. 1.—Fertilised egg of *Nautilus macromphalus* in the natural attached position.

The pectinate ridges and fenestrations, together with the slit in the wall of the outer capsule, are well seen. The arcuate thickening in the middle of the posterior half of the egg is due to the fusion of the outer with the inner capsule. In this ovum the anterior membranous prolongations of the outer capsule were unequal, the larger of them having the form of a thin flattened expansion.

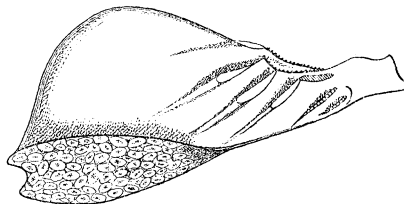


FIG. 2.—The same egg from the side, showing the inflated posterior or proximal portion and the more flattened distal portion, as also the spongy area of attachment.

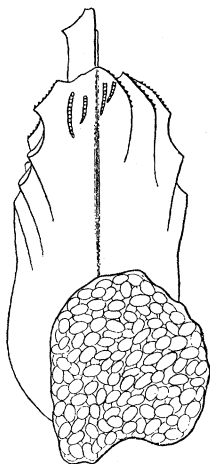


FIG. 3.—The same egg as in the preceding figures, from below. Behind is the somewhat irregularly shaped spongy area of attachment.

appearance. The anterior depressed region is characterised by the presence of a number of pectinate ridges and of fenestrations in the wall of the outer capsule (figs. 1—3). Sometimes, however, the pectinations are obscure and the fenestrations may be absent.

Hardly will any two eggs present an exactly similar appearance. Sometimes there are shred-like processes from the surface of the outer capsule, lending a more or less tattered appearance to the egg.

In fig. 4 another egg is shown with the above-described slit in the upper wall of the outer capsule, widened out so as to disclose the inner capsule to view.

The inner capsule has a regular oval shape with anterior pointed extremity and a generally smooth surface. Its wall has a finely striated structure, the striæ having a watery appearance. There are three distinct seams or sutures, representing lines of least resistance, in the wall of the inner capsule, namely, a median suture on the upper side (*i.e.*, the side directed away from the attached side of the egg), and two lateral sutures placed towards the lower surface of the capsule (figs. 4—6).

The dorsal suture is marked by a prominent ridge which is produced in front beyond the anterior extremity of the main body of the inner capsule into a slender terminal appendix.

The lateral sutures are marked by less prominent ridges, and are continued into one another anteriorly, immediately behind the anterior extremity of the inner capsule. In consequence of the continuity of the lateral sutures, the lower side of the egg can be raised up like a cap or an operculum. The inner capsule is often easily

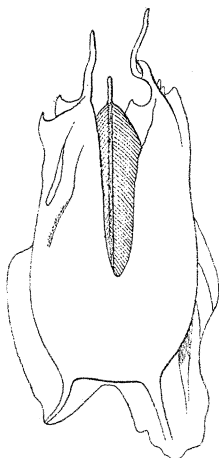


FIG. 4.—Another egg of *N. macromphalus*, seen from above, with the longitudinal slit in the upper wall of the outer capsule widened out so as to expose the inner capsule to view.

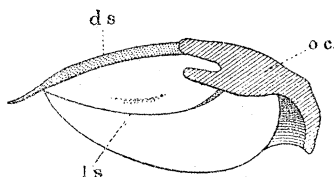


FIG. 5.—Inner capsule of another egg to show the dorsal ridge along the dorsal suture (*d. s.*) with its anterior terminal prolongation, and the lateral suture (*l. s.*). *o. c.*, remains of outer capsule.

ruptured along the sutures. In the middle line of the lower surface of the inner capsule there is a slight longitudinal groove, and other unimportant grooves often occur. Where the outer capsule is united to the inner capsule there is usually a depression or flattening in the wall of the latter.

The vitellus (fig. 6) does not fill the entire cavity of the inner capsule, but is surmounted by a layer of colourless, somewhat cloudy, viscid albumen which is massed up, as it were, at the two extremities of the egg. The yolk is of a rich brown colour, of very fluid consistency, and sub-translucent. The surface of the vitellus is quite smooth. The length of the inner capsule is about 26 mm., while that of the enclosed vitellus is 17 mm.

I am not in a position to say much about the embryonic area at present, but I have observed an area pellucida about the middle of

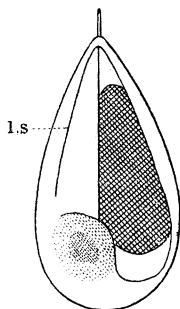


FIG. 6.—The inner capsule of the same egg, seen from below (*i.e.*, from the side directed towards the surface of attachment). Half the lower wall of the capsule has been removed by slitting along one of the lateral sutures, and along the median groove (mentioned in the text), to show the brown-coloured vitellus lying in the capsule. The continuity of the lateral sutures (*l. s.*) in front is well seen. The shaded area represents a depression which occurred in the wall of the inner capsule in the region of the area of attachment of the outer capsule.

the lower surface of the vitellus in an egg which had been allowed to develop for twenty-four hours after being first seen. The large quantity of yolk points to the occurrence of a long period of incubation.

Sometimes the capsules of the egg are malformed, and, on opening such an egg, the vitellus is found to be already ruptured.

From the fact that in New Britain I obtained mature males of *Nautilus pompilius*, carrying a spermatophore in the cephalic region throughout the year, I came to the conclusion that the reproduction of *Nautilus* took place all the year round. It now seems probable that the breeding of *Nautilus*, as of so many other forms, is subject to a definite law of periodicity.

Finally, it may be mentioned that *N. macromphalus* varies with regard to the position of the spadix on the right or left side, and also as to the origin of the siphuncular artery, in the same way as *N. pompilius* does. The male of *N. macromphalus* carries a spermatophore in the same position as in *N. pompilius*; and, in fact, the only essential difference between the two species that I know of at present, is the difference between the shells in the umbilical region.